Patent No. 2979522
Registration Date: September 17, 1999
Issue Date: November 15, 1999
Application No.: 6-30275
Application Date: February 28, 1994
Laid-open No.: 7-240536
Laid-open Date: September 12, 1995
Request for Examination Filing Date: December 5, 1995
Appeal No. 10-6062
Appeal Filing Date: April 16, 1996

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References
Patent Application Laid-Open No. 4-163968 (JP, A)
Utility Model Application Laid-Open No. 5-91619 (JP,U)
Utility Model Application Laid-Open No. 58-61423 (JP, U)

[Title of the Invention] LIGHT SOURCE DEVICE FOR CURING PHOTOPOLYMERIZATION RESIN

[Claims]

[Claim 1] A light source device for curing a photopolymelization resin comprising: a plurality of light emitting diodes having peak emission wavelength in a range of 430 to 480 nm; an optical system means for converging lights of the light emitting diodes; and a light irradiating means for outputting the light converged by the optical system means.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention relates to a light source device for curing a photopolymelization resin to be used as dental material.

[0002]

[Prior Art]

In the recent years, a photopolymelization resin adapted to be polymerized by a visible light has been rapidly spreading as dental material, such as for dentistry storage, repair and so forth. The photopolymelization resin is prepared by blending a photosensitizing agent in a monomer. The photosensitizing agent is decomposed by absorbing light irradiated. This initiates polymerizing reaction of the monomer. Such photopolymelization resin is advantageous for capability of varying a polymerizing reaction speed and a curing depth according to the irradiation intensity of the light. As

dental material, for example, as photosensitizing agent, α-diketones such as camphor quinone (CQ) is used, and as monomer, multifunctional methacrylates, such as methyl methacrylate and so forth is used. Camphor quinone absorbs light of wavelength of 410 to 500 nm, and particularly has high absorbing characteristics for the light of the wavelength of 430 to 480 nm.

[0003]

As a light source for curing such resin, a halogen lamp is typically employed. Since an output light of the halogen lamp contains lights of various wavelengths, lights of wavelengths close to 410 to 500 nm, in which camphor quinone has high absorbing ability, are selected by an optical filter to irradiate on the photopolymelization resin. Fig. 4 shows spectra of light irradiated from the conventional light source device and an absorptive wavelength band of camphor quinone. Since spectra A to D of the conventional light source device constructed with a combination of halogen lamp and optical filter is offset from absorptive wavelength band of camphor quinone toward long wavelength side, the light source does not effectively function for curing of camphor quinone.

[0004]

As apparent from the above, the conventional light source device taking halogen lamp as light source encounters the following drawbacks.

[0005]

1) A ratio of light in a wavelength range effective for

curing the photopolymelization resin is low. In order to overcome the lacking of polymerization and of curing depth of the photopolymelization resin, overall light intensity has to be made large a strong light having a high intensity of 500 to 1000 mW/cm^2 in the irradiation opening is required so that a problem in viewpoint of safety encounters.

[0006]

On the other hand, even when the device having high light intensity is employed, it can still be insufficient as light intensity required for curing the photopolymelization resin. For sufficiently curing the resin, the irradiation opening has to be placed quite close to affected part to inherently cause stain or breakage of the irradiation opening.

[0007]

On the other hand, light emission of halogen lamp generates strong heat, so that a cooling by a cooling fan is required. Further when a concave mirror is employed as an optical system means for converging the light, the concave mirror can be easily clouded to be frequently maintained.

[0008]

2) The light source and the concave mirror may cause fatigue; the user is required to constantly monitor the light amount for adjusting irradiation period.

[0009]

3) As set forth, in order to obtain high light intensity, the power source becomes bulky, the cooling device has to be provided and so forth, which encounter drawback of increasing

size and weight of the device.

[0010]

[Problem to be Solved by the Invention]

The present invention has been worked out for solving the foregoing problem. It is an object to provide a light source for curing a photopolymelization resin which can enhance polymerizing efficiency of the photopolymelization resin, avoid influence of heat to be safe, does not cause fatigue of the light source, and is compact and superior operation ability.

[0011]

[Means for Solving the Problem]

The present invention comprises a plurality of light emitting diodes having peak emission wavelength in a range of 430 to 480 nm; an optical system means for converging lights of the light emitting diodes; and a light irradiating means for outputting the light converged by the optical system means.

[0012]

[Function]

The lights output from the light emitting diodes are converged to a light irradiation head through the optical system means. This light is discharged from the irradiating opening at the other end of the light irradiating head via the light irradiating head. Then, the output light is irradiated on the photopolymelization resin applied to the affected part to polymerize the photopolymelization resin.

[0013]

[Embodiment]

(First Embodiment) Fig. 1 is a block diagram showing a general construction of the first embodiment of a light source device for curing a photopolymelization resin according to the present invention. The reference numeral 1 denotes a power source, 2 denotes resistors, 3 denote LEDs (light emitting diodes), 3a denote LED chips forming the LEDs, 4 denotes optical fibers, 5 denotes a light irradiating head formed by bundling one ends of the optical fibers, and 5a denotes an irradiating opening.

[0014]

Next, discussion will be given for operation of the light source device for curing the photopolymelization resin of Fig. 1. The LEDs 3 applied bias voltage from the power source 1 through the resisters 3 emit light from the LED chips 3a. The LEDs 3 have peak emission wavelengths in a range of 430 to 480 nm. In the shown embodiment, twenty LEDs having peak emission wavelength of 455 nm and light output of 1200 μW are used. Discharge lights enter to one ends of optical fibers 4 directly connected to or placed in the vicinity of the LED chips 3a and propagate to the other ends of the optical fibers 4 through the optical fibers 4. Lights passing through the optical fibers 4 are converged by the optical irradiation head 5 which is formed by bundling the other ends of a plurality of optical fibers 4 and bound by a resin, and discharged from the irradiation opening 5a of the light irradiating head 5 as the discharge light. The discharge light thus taken out is irradiated on the photopolymelization resin applied and filled in the affected part to cure the resin.

[0015]

Next, discussion will be given for curing of the photopolymelization resin in the shown embodiment. Fig. 4 shows spectra of light irradiated from the light source device of the present invention and an absorptive wavelength band of camphor quinone. As shown in Fig. 4, large part of the spectra E of the output light of the light source device for curing the photopolymelization resin of the shown embodiment is within the wavelength range of 430 to 480 nm effective for absorption by camphor quinone.

[0016]

Accordingly, such output light is irradiated on the photopolymelization resin, the photopolymelization resin can be polymerized satisfactorily by light output in the extent of one several tenth of the conventional light source.

[0017]

Particularly, in the shown embodiment, the light incident surface of light converging fibers can be arranged in contact with or quite close to the light emitting element of the LED chip to enhance converging efficiency and make the power higher.

[0018]

(Second Embodiment) Fig. 2 is a block diagram showing a general construction of the second embodiment of the light source device for curing the photopolymelization resin according to the present invention. In the drawings, 5' denotes a light irradiating head, 5'a denotes an incident opening, 5'b is an

irradiating opening, 6 denotes a convergence lens and 1 to 3 denote the same parts shown in Fig. 1.

[0019]

Next, discussion will be given for operation of the light source device for curing the photopolymelization resin of Fig. 2. Similarly to Fig. 1, twenty LEDs 3 having the peak emission wavelength in a range of 430 to 480 nm, in particularly 455 nm, twenty and having light output of 1200 μW are arranged on the same circle. These discharge lights are converged by the convergence lens 6 and are projected on the surface of the incident opening 5'a of the light irradiating head 5' arranged in parallel on an optical axis of the convergence lens 6. The light irradiating head 5' of this embodiment is formed by bundling a plurality of optical fibers of substantially equal lengths ands bound by the resin. However, the light irradiating head may be formed by a hollow pipe of metal or resin provided at inner surface thereof circle aluminum coating for total reflection of the LED lights or by a glass rod per se.

[0020]

The light converged by the light irradiating head 5' is taken out as discharge light from the irradiating opening 5'b through the light irradiating head 5'. The discharge light thus taken out is irradiated on the photopolymelization resin applied and filled in the affected party to cure the resin.

[0021]

It should be noted that concerning the curing of the

photopolymelization resin in this embodiment, the discussion will be eliminated as being similar to the first embodiment.

[0022]

(Third Embodiment) Fig. 3 is a block diagram showing a general construction of the third embodiment of the light source device for curing the photopolymelization resin according to the present invention, which is an embodiment employing a concave mirror 7 as an output light converging system of respective LEDs.

[0023]

In this embodiment, the LEDs are same as those used in the first and second embodiments. The discharge lights from respective LEDs are reflected by the concave mirror 7 and converged to the surface of the incident opening 5'a of the light irradiating head 5'. Respective LEDs 3 are arranged so that the discharge lights are converged by the concave mirror 7 toward the center of the incident opening 5a' of the light irradiating head 5' arranged in parallel on the optical axis of the concave mirror 7. The light irradiating head 5' is formed by binding a plurality of optical fibers in substantially equal length by resin. However, similarly to the foregoing, the optical irradiating head may be constructed with the hollow pipe of metal or resin, or glass rod.

[0024]

It should be noted that curing of the photopolymelization resin in this embodiment is similar to that in the first embodiment. Thus, discussion will be eliminated.

[0025]

Particularly, in this embodiment, since the LEDs having the discharge light wavelengths which are almost within 430 to 480 nm which are absorptive wavelengths of camphor quinone are employed, the resin can be cured with the light of minimum intensity. Conventionally, for curing the resin by halogen light source, intensity of the overall light source is made large to pull up the intensity of the light of the absorptive wavelength band of camphor quinone. At the same time, the light intensity of the wavelength band unnecessary for curing the resin is also pulled up. Then, heat generation by the discharge light containing such unnecessary light causes clouding of the concave mirror. However, this problem can be solved by the present invention.

[0026]

On the other hand, the present invention includes the following embodiments.

[0027]

(1) Per each LED, the convergence lens is arranged on the front surface of the LED chip light emitting element for converging light discharged from the LED.

[0028]

(2) As optical system means, instead of using the optical fiber, convergence lens and so forth, with the hollow pipe reducing internal diameter toward the irradiating opening, with aluminum coating on the inner surface thereof for total reflection of the LED light, may be used for converging the

light emitted from the LEDs.

[0029]

(3) By placing the lens on the irradiating opening of the light irradiating head, the discharge light may be collimated. At this time, it becomes unnecessary to place the irradiating opening in the vicinity of the affected part.

[0030]

[Effect of the Invention]

The light source device for curing the photopolymelization resin according to the present invention employs a plurality of LEDs as light emitting source and selects the wavelength of the discharged light within the wavelength range of 430 to 480 nm which is a absorptive wavelength band of camphor quinone, thereby permitting a sufficient polymerization of the photopolymelization resin with the light of smaller intensity than that in the prior art. By this, the power source can be made compact. On the other hand, since sufficient light intensity can be obtained, the irradiating opening is not required to be placed close to the affected part. Further, by collimating the discharge light by placing the lens on the irradiating opening of the light irradiating head, the irradiating opening can be placed away from the affected part to reduce stain and breakage of the irradiating opening. Since heat is not generated, the light source device can be safe and the cooling fan becomes unnecessary. Furthermore, clouding of the concave mirror as the converging optical system means of the third embodiment can be reduced.

[0031]

The light emitting diode as the light source hardly fatigue, is not necessary to adjust per use, and permits continuous use for long period.

[0032]

As described above, the power source can be small and the cooling fan becomes unnecessary to permit the overall device to be compact.

[Brief Description of the Drawing]

[Fig. 1]

A block diagram showing a general construction of one embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which optical fibers are used as converging optical system;

[Fig. 2]

A block diagram showing a general construction of another embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which convergence lens are used as converging optical system;

[Fig. 3]

A block diagram showing a general construction of the a further embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which a concave mirror is used as converging optical system; and

[Fig. 4]

An illustration showing a relationship of spectra of

light obtained by the conventional light source device, a spectra of light obtained by the light source device of the embodiment of the present invention, and an absorptive wavelength band of camphor quinone.

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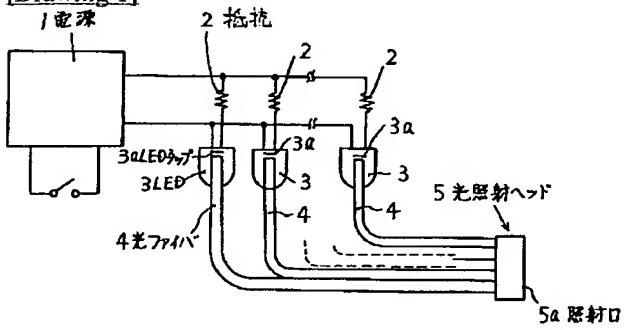
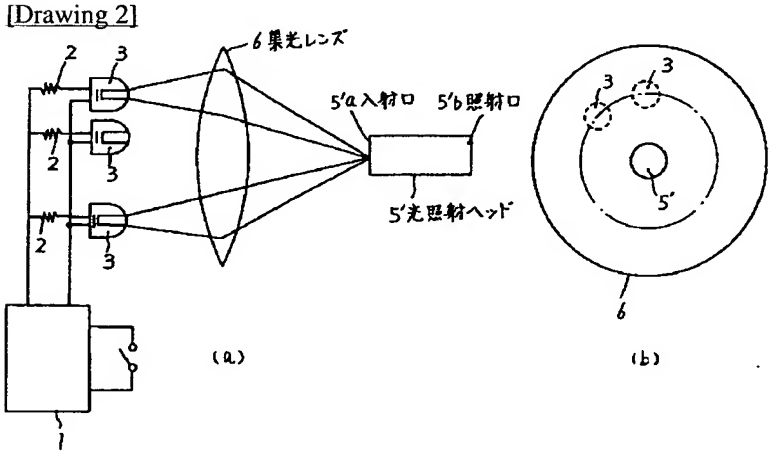
DRAWINGS

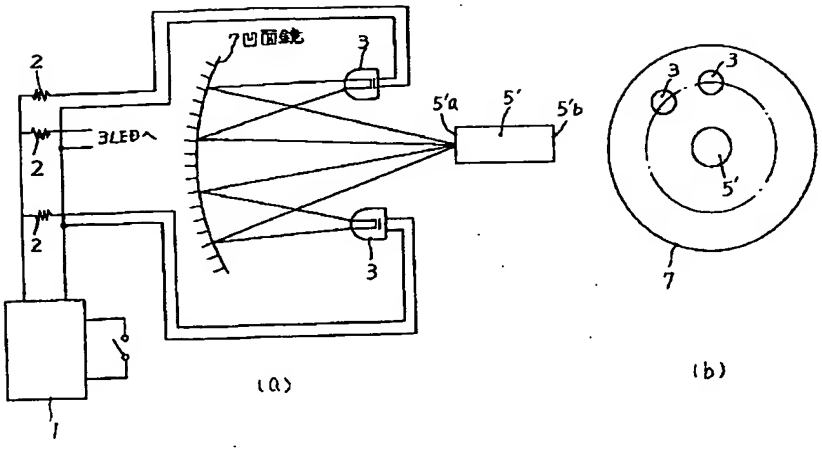
[Drawing 1]



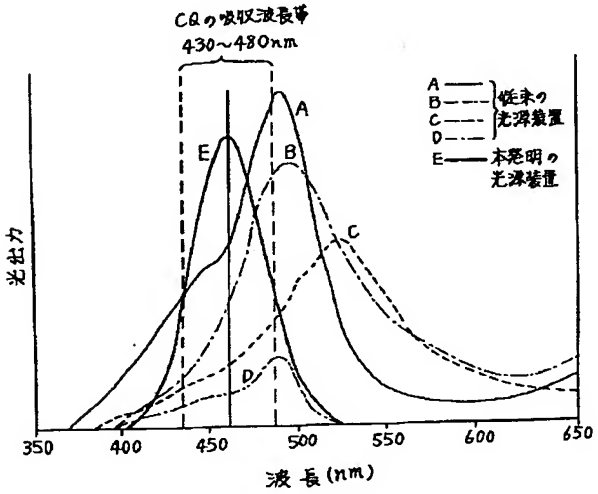
[Drawing 2]



[Drawing 3]



[Drawing 4]



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CLAIMS

[Claim(s)]
[Claim 1] Light equipment for photopolymerized type resin hardening characterized by constituting by two or more light emitting diodes in the domain whose peak emission wavelength is 430-480nm, optical-system means to condense the light of these light emitting diodes, and optical irradiation means to output the light condensed with this optical-system means.

[Translation done.]

[Patent number]	2979522
[Date of registration]	17.09.1999
[Number of appeal against examiner's decision of rejection]	10-06062
[Date of requesting appeal against examiner's decision of rejection]	16.04.1998
[Date of extinction of right]	

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the light equipment for stiffening the photopolymerized type resin used as dental material.
[0002]
[Description of the Prior Art] Recently, the photopolymerized type resin which carries out a polymerization by the visible ray as dental material for a dentistry store repair etc. has spread quickly. As for photopolymerized type resin, the photosensitizer was blended into the monomer, when optical irradiation of the photosensitizer is carried out, light is absorbed, it decomposes and this makes the polymerization reaction of a monomer start. Such photopolymerized type resin has the advantage of the grade which can change a polymerization reaction rate and a case depth with the irradiation intensity of light. As dental material, as for a photosensitizer, alpha-diketones, such as a camphor quinone (CQ), are used, and, as for the monomer, polyfunctional methacrylate, such as methyl methacrylate, is used, for example. Although a camphor quinone absorbs light with a wavelength of 410-500nm, it has a sharp absorption property to 430-480nm wavelength light especially.
[0003] Generally as light source for stiffening such resin, the halogen lamp is used. Since the light of various wavelength is contained, the output light of a halogen lamp chooses light with a wavelength [which a camphor quinone absorbs well] of 410-about 500nm with a light filter, and it constitutes it so that photopolymerized type resin may be irradiated. the spectrum of the light irradiated from conventional light equipment by drawing 4 -- a spectrum and the absorption wavelength band of á camphor quinone are shown the spectrum of the conventional light equipment which consists of the combination of a halogen lamp and a light filter -- spectrums A-D -- the absorption wavelength band of a camphor quinone -- a long wave -- since it has shifted to the merit side, it turns out that this light source is not functioning effective in hardening of a camphor quinone
[0004] The conventional light equipment which uses a halogen lamp as the light source had the following faults so that it might understand also above.
[0005] 1) in order the rate of the light of a wavelength domain effective in hardening of photopolymerized type resin is low and to solve the shortage of a polymerization and the shortage of a case depth of photopolymerized type resin -- the luminous intensity as whole -- large -- it is necessary to carry out -- near the irradiation opening -- setting -- 500-1000mW/cm2 ** -- a strong light to say had to be treated and the big problem was in the safety aspect
[0006] Moreover, even if it used the large equipment of such luminous intensity, as luminous intensity required for hardening of photopolymerized type resin, it may be inadequate, and in order to fully harden resin, the irradiation opening had to be made to approach to very near the affected part, and it was surely accompanied by the dirt of the irradiation opening, or the crash.
[0007] Moreover, since it was accompanied by strong generation of heat, photogenesis of a halogen lamp needed cooling by the cooling fan. Moreover, as an optical-system means for condensing light, when a concave mirror was used, it needed to maintain frequently by this concave mirror tending to

become cloudy.
[0008] 2) Moreover, since the light source and a concave mirror deteriorated, always, the user needed to do the monitor of the quantity of light, and needed to adjust irradiation time.
[0009] 3) as mentioned above, in order to obtain strong luminous intensity, power needs to large-sized-ize or it is necessary to prepare a cooling system -- etc. -- there was a fault which equipment forms into a large-sized weight
[0010]
[Problem(s) to be Solved by the Invention] It was originated in order that this invention might solve the above-mentioned trouble, and the influence by heat is eliminated, and the purpose is safe and is offering the light equipment for photopolymerization type resin hardening without a light source degradation which was compact and was excellent in operability while it raises the polymerization luminous efficacy of photopolymerized type resin.
[0011]
[Means for Solving the Problem] this invention is characterized by establishing the light emitting diode in the domain whose peak emission wavelength is 430-480nm, an optical-system means to condense the light of the concerned light emitting diode, and an optical irradiation means to output the light condensed with the concerned optical-system means.
[0012]
[Function] The light outputted from light emitting diode is condensed by the optical irradiation head by the optical-system means. This light passes through an optical irradiation head, and an outgoing radiation is carried out from the irradiation opening which is the other end of the concerned optical irradiation head. And when the photopolymerized type resin which the concerned output light applied to the affected part irradiates, photopolymerized type resin carries out a polymerization.
[0013]
[Example]
(The 1st example) The optical irradiation head and 5a which are constituted by view 1 being the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 1st example of this invention, Light Emitting Diode chip with which power and 2 constitute resistance and Light Emitting Diode (light emitting diode) and 3a constitute [1] Light Emitting Diode in 3, and 4 bundling an optical fiber, and 5 bundling the end of an optical fiber are the irradiation opening.
[0014] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 1 is explained. Each Light Emitting Diode3 to which bias voltage was impressed through resistance 2 from power 1 emits light from Light Emitting Diode chip 3a. In the domain whose peak emission wavelength is 430-480nm, especially this example, Light Emitting Diode3 is a 455nm thing, and used 20 things whose optical outputs are 1200microW. After carrying out incidence of this outgoing-radiation light to a direct file or the end of an optical fiber 4 which approached at Light Emitting Diode chip 3a, it passes along the inside of this optical fiber 4, and progresses to the other end of an optical fiber 4. The other end of two or more optical fibers 4 is bundled, it is condensed by the optical irradiation head 5 hardened by the resin, and the light which has advanced the inside of an optical fiber 4 is taken out from irradiation opening 5a of the optical irradiation head 5 as outgoing-radiation light. Thus, when the taken-out outgoing-radiation light is irradiated by the photopolymerized type resin which carried out application restoration at the affected part, this resin hardens.
[0015] Next, hardening of the photopolymerization resin in this example is described. the spectrum of light with which drawing 4 is irradiated from the light equipment of this invention -- a spectrum and the absorption wavelength band of a camphor quinone are shown it is shown in drawing 4 -- as -- the spectrum of the output light of the light equipment for photopolymerized type resin hardening of this example -- the great portion of spectrum E is contained in the wavelength domain effective in absorption of a camphor quinone of 430-480nm
[0016] Therefore, if such output light is irradiated at photopolymerized type resin, the polymerization of the photopolymerized type resin can fully be carried out by 1/about some dozens optical output of the

conventional light source.
[0017] especially -- this example -- the optical plane of incidence of the fiber for condensing -- the light emitting device of Light Emitting Diode chip -- contact -- or it approaches extremely, and since it can arrange, condensing luminous efficacy becomes good and power can also be made high
[0018] (The 2nd example) View 2 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 2nd example of this invention, for 5', an optical irradiation head and 5'a of the incidence opening and 5'b are [the irradiation opening and 6] condenser lenses among drawing, and 1-3 show the same parts as drawing 1 .
[0019] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 2 is explained. Light Emitting Diode3 has arranged 20 pieces for the domain whose peak emission wavelength is 430-480nm, and the thing whose optical output it is especially 455nm and is 1200microW on the same periphery as well as drawing 1 . these -- an outgoing radiation -- light -- a condenser lens -- six -- condensing -- having -- a condenser lens -- six -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- projecting -- having . optical irradiation head 5' of this example -- abbreviation -- although two or more optical fibers of the same length were bundled and being considered as the briquette by the resin, it is a metal or the hollow pipe of a resin, and you may constitute from the thing and the glass rod itself which carried out aluminum coating so that Light Emitting Diode light might carry out total reflection of the wall
[0020] And the light condensed by optical irradiation head 5' is taken out from the irradiation opening 5'b as outgoing-radiation light through this optical irradiation head 5'. Thus, when the photopolymerized type resin which carried out application restoration irradiates at the affected part, this resin hardens the taken-out outgoing-radiation light.
[0021] In addition, about hardening of the photopolymerized type resin in this example, since it is the same as that of the 1st example, the explanation is omitted.
[0022] (The 3rd example) View 3 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 3rd example of this invention, and it is the example using the concave mirror 7 as an output light condensing system of each Light Emitting Diode.
[0023] Also in this example, Light Emitting Diode used the same thing as the 1st and the 2nd example. each -- Light Emitting Diode -- **** -- an outgoing radiation -- light -- a concave mirror -- seven -- reflecting -- having -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- condensing -- having -- although -- each -- Light Emitting Diode -- three -- an outgoing radiation -- light -- a concave mirror -- seven -- a concave mirror -- seven -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening moreover, optical irradiation head 5' -- the 2nd example -- the same -- abbreviation -- although two or more optical fibers of the same length were made into the briquette by the resin -- the above -- the same -- a metal or the hollow pipe made from a resin -- or you may constitute from a glass rod etc.
[0024] In addition, about hardening of the photopolymerized type resin in this example, it is the same as that of the 1st example, and an explanation is omitted.
[0025] Especially, at this example, since most outgoing-radiation light wave length uses Light Emitting Diode which is 430-480nm of the absorption wavelength band of a camphor quinone, resin can be stiffened by the minimum luminous intensity. Although generation of heat by the outgoing-radiation light to which it will also pull up the luminous intensity of an unnecessary wavelength band to hardening of resin, and contains such an unnecessary light in it simultaneously although the intensity as the whole light source was enlarged and the luminous intensity of the absorption wavelength band of a camphor quinone was pulled up by it in order to stiffen resin with the halogen light source conventionally caused the cloudy weather of a concave mirror, this trouble is cancelable with this invention.
[0026] By the way, the following examples are also included as an embodiment of this invention.
[0027] (1) In each Light Emitting Diode unit, a condenser lens may be arranged in the front face of Light Emitting Diode chip light emitting device, and the light which emits light from this Light Emitting

Diode may be condensed.
[0028] (2) You may condense the light which carried out aluminum coding and which emits light from Light Emitting Diode in the hollow pipe in which a bore becomes small so that Light Emitting Diode light may carry out total reflection of the wall as the irradiation opening is approached instead of using an optical fiber, a condenser lens, etc. as an optical-system means.
[0029] (3) A lens may be put on the irradiation opening of an optical irradiation head, and you may collimate outgoing-radiation light. It is not necessary to make the irradiation opening approach the affected part at this time.
[0030]
[Effect of the Invention] Since two or more Light Emitting Diodes were used for the light equipment for photopolymerized type resin hardening of this invention as the source of photogenesis and it selected outgoing-radiation light wave length in the wavelength domain of 430-480nm which is the absorption wavelength band of a camphor quinone, it can fully carry out the polymerization of the photopolymerized type resin with the light of an intensity smaller than the former as whole. Power can be miniaturized by this. Moreover, since sufficient luminous intensity is obtained, by it not being necessary to make the irradiation opening approach extremely to the affected part and, putting a lens on the irradiation opening of an optical irradiation head, and collimating outgoing-radiation light, the irradiation opening can be further separated from the affected part, and the dirt of the irradiation opening and a crash decrease. Moreover, since heat does not occur, it is safe, a cooling fan becomes unnecessary, and the cloudy weather of the concave mirror which is the condensing optical-system means of the 3rd example further decreases.
[0031] Moreover, the light emitting diode which is the light source has very few degradations, there is no need for the adjustment for every use, and the prolonged continuous duty of it becomes possible.
[0032] Moreover, since power can be miniaturized and a cooling fan also becomes unnecessary as mentioned above, miniaturization of the whole equipment can be attained.

[Translation done.]

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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-240536

(43)Date of publication of application : 12.09.1995

(51)Int.Cl. H01L 33/00
A61C 13/15

(21)Application number : 06-030275

(22)Date of filing : 28.02.1994

(71)Applicant : SHIMADZU CORP

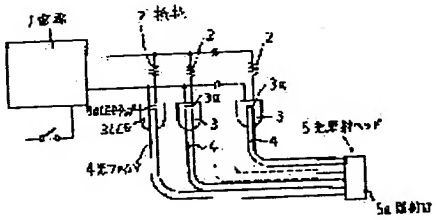
(72)Inventor : AKITA TOMOHITO

(54) PHOTOPOLYMERIZATION-TYPE RESIN SETTING OPTICAL SOURCE DEVICE

(57)Abstract:

PURPOSE: To provide a light source which is safe, restrained from deteriorating in intensity, free from thermal troubles, lightweight, compact in structure, and used for curing photopolymerization-type resin well.

CONSTITUTION: LEDs(light emitting diode) 3 which emit light rays of peak wavelengths 430 to 380nm and optical fibers 4 which serve as optical means which condense light rays emitted from the LEDs 3 and whose ends are bound up into a light irradiating head 5 are provided, and light rays emitted from the light irradiating head 5 are made to irradiate photopolymerization-type resin.



LEGAL STATUS

[Date of request for examination] 05.12.1995

[Date of sending the examiner's decision of rejection] 17.03.1998

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is one example of this invention shows the example using the optical fiber as condensing optical system.
[Drawing 2] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is other examples of this invention shows the example using the condenser lens as condensing optical system.
[Drawing 3] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is other examples of this invention shows the example using the concave mirror as condensing optical system.
[Drawing 4] the spectrum of the light obtained with conventional light equipment -- the spectrum of the light obtained with a spectrum and the light equipment of this invention example -- it is drawing showing the relation between a spectrum and the absorption wavelength band of a camphor quinone

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[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平7－240536

(43)公開日　平成７年(1995)９月12日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ　33/00	Ｍ			
Ａ６１Ｃ　13/15				
		7108－4C	Ａ６１Ｃ　13/14	Ｂ

審査請求　未請求　請求項の数１　ＯＬ　（全５頁）

(21)出願番号　特願平6－30275

(22)出願日　平成６年(1994)２月23日

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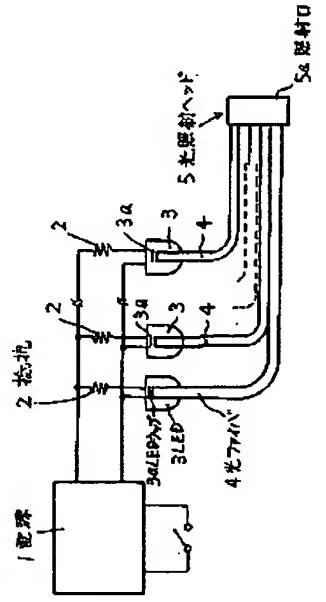
(54)【発明の名称】　光重合型レジン硬化用光源装置

(57)【要約】
【目的】　光重合型レジンの重合が充分となり、安全で、光源の劣化がなく、熱的問題がなく、軽くてコンパクトな光重合型レジン硬化用の光源を提供する。
【構成】ピーク発光波長が４３０～４８０ｎｍの範囲である光を発光する複数のＬＥＤ（発光ダイオード）３と、当該ＬＥＤ３より発光された光を集光する光学系手段であって、一端を束ねられ光照射ヘッド５を形成する光ファイバ４とを設け、前記光照射ヘッド５から出力された光が、光重合型レジンに照射される。



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【特許請求の範囲】

【請求項1】　ピーク発光波長が430～480nmの範囲にある複数の発光ダイオードと、これら発光ダイオードの光を集光する光学系手段と、この光学系手段で集光された光を出力する光照射手段とによって構成したことを特徴とする光重合型レジン硬化用光源装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、歯科材料として用いられる光重合型レジンを硬化させるための光源装置に関する。

【0002】

【従来の技術】最近、歯科保存修復用等の歯科材料として可視光線で重合する光重合型レジンが急速に普及している。光重合型レジンは、モノマー中に光増感剤が配合されたもので、光増感剤は光照射されると光を吸収して分解し、これがモノマーの重合反応を開始させる。このような光重合型レジンは、光の照射強度により重合反応速度および硬化深度を変えることができる等の利点を有する。歯科材料としては、例えば光増感剤はカンファーキノン（CQ）等のα－ジケトン類、モノマーはメチルメタクリレート等の多官能メタクリレート類が用いられている。カンファーキノンは、410～500nmの波長の光を吸収するが、特に430～480nmの波長光に対して鋭い吸収特性を持っている。

【0003】このようなレジンを硬化させるための光源としては、一般にハロゲンランプが用いられている。ハロゲンランプの出力光は、いろいろな波長の光が含まれているため、カンファーキノンがよく吸収する410～500nmに近い波長の光を、光学フィルタで選択して、光重合型レジンに照射するように構成している。図4に、従来の光源装置から照射される光の分光スペクトルと、カンファーキノンの吸収波長帯とを示す。ハロゲンランプと光学フィルタとの組合せから構成される従来の光源装置の分光スペクトルA～Dが、カンファーキノンの吸収波長帯よりも長波長側にずれているため、この光源はカンファーキノンの硬化に有効に機能していないことがわかる。

【0004】以上でもわかるように、ハロゲンランプを光源とする従来の光源装置は、以下の欠点があった。

【0005】1）光重合型レジンの硬化に有効な波長範囲の光の割合が低く、光重合型レジンの重合不足および硬化深度不足を解決するためには、全体としての光の強度を大きくする必要があり、照射口付近において500～1000mW／cm2という強い光を扱わなければならず、安全面に大きな問題があった。

【0006】また、このような光の強度の大きい装置を使用しても、光重合型レジンの硬化に必要な光の強度としては不充分な場合があり、レジンを充分に硬化するためには、照射口を患部のごく近くまで接近させなければ

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ならず、どうしても照射口の汚れや破損を伴った。

【0007】また、ハロゲンランプの発光は強い発熱を伴うため、冷却ファンによる冷却を必要とした。また、光を集光するための光学系手段として、凹面鏡を使用した場合、この凹面鏡がくもりやすく、メンテナンスを頻繁に行う必要があった。

【0008】2）また、光源及び凹面鏡が劣化するため、常に使用者が光量をモニタして照射時間を調整する必要があった。

【0009】3）上述したように、強い光の強度を得るために、電源が大型化したり冷却装置を設ける必要があるなど、装置が大型重量化する欠点があった。

【0010】

【発明が解決しようとする課題】本発明は、上記の問題点を解決するために創案されたもので、その目的は、光重合型レジンの重合効率を高めるとともに、熱による影響を排除し安全で、光源劣化のない、コンパクトで操作性に優れた光重合型レジン硬化用光源装置を提供することである。

【0011】

【課題を解決するための手段】本発明は、ピーク発光波長が430～480nmの範囲にある発光ダイオードと、当該発光ダイオードの光を集光する光学系手段と、当該光学系手段で集光された光を出力する光照射手段とを設けたことを特徴とする。

【0012】

【作用】発光ダイオードから出力された光は、光学系手段によって光照射ヘッドに集光される。この光は、光照射ヘッドを経て、当該光照射ヘッドの他端である照射口から出射される。そして、当該出力光が患部に塗布した光重合型レジンに照射されることにより、光重合型レジンが重合する。

【0013】

【実施例】

（第1実施例）図1は、本発明の第1実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、1は電源、2は抵抗、3はLED（発光ダイオード）、3aはLEDを構成するLEDチップ、4は光ファイバ、5は光ファイバの一端を束ねて構成される光照射ヘッド、5aは照射口である。

【0014】次に、図1の光重合型レジン硬化用光源装置の動作を説明する。電源1から、抵抗2を介してバイアス電圧を印加された各LED3は、LEDチップ3aから光を発する。LED3は、ピーク発光波長が430～480nmの範囲、特に本実施例では455nmのもので、光出力が1200μWのものを20個使用した。この出射光は、LEDチップ3aに直接接続もしくは近接された光ファイバ4の一端に入射した後、この光ファイバ4内を通って、光ファイバ4の他端へ進む。光ファイバ4内を進行してきた光は、複数の光ファイバ4の他

端が束ねられ、樹脂で固められた光照射ヘッド5により集光されて、光照射ヘッド5の照射口5ａから、出射光として取り出される。このようにして取り出された出射光が、患部に塗布充填した光重合型レジンに照射されることによって、このレジンが硬化する。

【００１５】次に、本実施例における光重合レジンの硬化について述べる。図４は、本発明の光源装置から照射される光の分光スペクトルと、カンファーキノンの吸収波長帯とを示す。図４に示すように、本実施例の光重合型レジン硬化用光源装置の出力光の分光スペクトルＥの大部分は、カンファーキノンの吸収に有効な波長範囲４３０～４８０ｎｍに含まれる。

【００１６】したがって、このような出力光を光重合型レジンに照射すると、従来の光源の数十分の１程度の光出力で、充分に光重合型レジンを重合させることができる。

【００１７】特に、本実施例では集光用ファイバの光入射面をＬＥＤチップの発光素子に当接又はきわめて近接して配置できるので、集光効率がよくなり、パワーも高くできる。

【００１８】（第２実施例）図２は、本発明の第２実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、図中、５′は光照射ヘッド、５′ａは入射口、５′ｂは照射口、６は集光レンズで、１～３は図１と同一部品を示す。

【００１９】次に、図２の光重合型レジン硬化用光源装置の動作を説明する。ＬＥＤ３は、図１と同じく、ピーク発光波長が４３０～４８０ｎｍの範囲、特に４５５ｎｍのもので、光出力が１２００μＷのものを、同一円周上に２０個を配置した。これらの出射光は、集光レンズ６によって集光され、集光レンズ６の光軸上に平行に配された光照射ヘッド５′の入射口５′ａの面に投射される。この例の光照射ヘッド５′は、略同一の長さの複数の光ファイバを束ねて樹脂で固めたものとしたが、金属もしくは樹脂の中空パイプで、内壁をＬＥＤ光が全反射するようにアルミコーティングしたものやガラス棒自体で構成したものであってもよい。

【００２０】そして、光照射ヘッド５′に集光された光は、この光照射ヘッド５′を通ってその照射口５′ｂから、出射光として取り出される。このようにして取り出された出射光は、患部に塗布充填した光重合型レジンに照射されることによって、このレジンが硬化する。

【００２１】なお、本実施例における光重合型レジンの硬化については、第１実施例と同様であるのでその説明を省略する。

【００２２】（第３実施例）図３は、本発明の第３実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、各ＬＥＤの出力光集光系として凹面鏡７を用いた例である。

【００２３】本実施例においても、ＬＥＤは第１、第２

実施例と同一のものを使用した。各ＬＥＤからの出射光は、凹面鏡７で反射され光照射ヘッド５′の入射口５′ａの面に集光されるが、各ＬＥＤ３は、出射光が凹面鏡７により、凹面鏡７の光軸上に平行に配された光照射ヘッド５′の入射口５′ａの中心に集光されるように配置される。また、光照射ヘッド５′は、第２実施例と同様に、略同一の長さの複数の光ファイバを樹脂で固めたものとしたが、前記同様に、金属もしくは樹脂製の中空パイプでまたはガラス棒などで構成してもよい。

【００２４】なお、本実施例における光重合型レジンの硬化については、第１実施例と同様であり、説明を省略する。

【００２５】特に、本実施例では、出射光波長の大部分がカンファーキノンの吸収波長帯の４３０～４８０ｎｍであるＬＥＤを使用するので、最小限の光の強度でレジンを硬化させることができる。従来、ハロゲン光源でレジンを硬化させるためには、光源全体としての強度を大きくし、それによってカンファーキノンの吸収波長帯の光の強度を引き上げていたが、それが同時にレジンの硬化に不要な波長帯の光の強度をも引き上げることとなり、そのような不要な光を含む出射光による発熱が凹面鏡のくもりを引き起こしたが、本発明によりこの問題点を解消することができる。

【００２６】ところで、本発明の実施態様としては、以下のような実施例も含まれる。

【００２７】（１）各ＬＥＤ単位で、ＬＥＤチップ発光素子の前面に集光レンズを配置して、このＬＥＤから発光する光を集光してもよい。

【００２８】（２）光学系手段として、光ファイバ、集光レンズ等を使用する代わりに、照射口に近づくにつれて内径が小さくなる中空パイプで、内壁をＬＥＤ光が全反射するようなアルミコーディングしたもので、ＬＥＤから発光する光を集光してもよい。

【００２９】（３）光照射ヘッドの照射口にレンズを置いて、出射光をコリメートしてもよい。このとき、照射口を患部に近接させなくてもよい。

【００３０】

【発明の効果】本発明の光重合型レジン硬化用光源装置は、その発光源として複数のＬＥＤを採用し且つ出射光波長を、カンファーキノンの吸収波長帯である４３０～４８０ｎｍの波長範囲に選定したので、全体としては、従来より小さな強度の光で光重合型レジンを充分に重合することができる。これによって、電源を小型化することができる。また、充分な光の強度が得られるので、照射口を患部まできわめて接近させなくてもよく、また光照射ヘッドの照射口にレンズを置いて出射光をコリメートすることで、さらに照射口を患部から離すことができ、照射口の汚れや破損が低減する。また、熱が発生しないので、安全で、冷却ファンが不要となり、さらに第３実施例の集光光学系手段である凹面鏡のくもりが低減

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the light equipment for stiffening the photopolymerized type resin used as dental material.
[0002]
[Description of the Prior Art] Recently, the photopolymerized type resin which carries out a polymerization by the visible ray as dental material for a dentistry store repair etc. has spread quickly. As for photopolymerized type resin, the photosensitizer was blended into the monomer, when optical irradiation of the photosensitizer is carried out, light is absorbed, it decomposes and this makes the polymerization reaction of a monomer start. Such photopolymerized type resin has the advantage of the grade which can change a polymerization reaction rate and a case depth with the irradiation intensity of light. As dental material, as for a photosensitizer, alpha-diketones, such as a camphor quinone (CQ), are used, and, as for the monomer, polyfunctional methacrylate, such as methyl methacrylate, is used, for example. Although a camphor quinone absorbs light with a wavelength of 410-500nm, it has a sharp absorption property to 430-480nm wavelength light especially.
[0003] Generally as light source for stiffening such resin, the halogen lamp is used. Since the light of various wavelength is contained, the output light of a halogen lamp chooses light with a wavelength [which a camphor quinone absorbs well] of 410-about 500nm with a light filter, and it constitutes it so that photopolymerized type resin may be irradiated. the spectrum of the light irradiated from conventional light equipment by drawing 4 -- a spectrum and the absorption wavelength band of a camphor quinone are shown the spectrum of the conventional light equipment which consists of the combination of a halogen lamp and a light filter -- spectrums A-D -- the absorption wavelength band of a camphor quinone -- a long wave -- since it has shifted to the merit side, it turns out that this light source is not functioning effective in hardening of a camphor quinone
[0004] The conventional light equipment which uses a halogen lamp as the light source had the following faults so that it might understand also above.
[0005] 1) in order the rate of the light of a wavelength domain effective in hardening of photopolymerized type resin is low and to solve the shortage of a polymerization and the shortage of a case depth of photopolymerized type resin -- the luminous intensity as whole -- large -- it is necessary to carry out -- near the irradiation opening -- setting -- 500-1000mW/cm2 ** -- a strong light to say had to be treated and the big problem was in the safety aspect
[0006] Moreover, even if it used the large equipment of such luminous intensity, as luminous intensity required for hardening of photopolymerized type resin, it may be inadequate, and in order to fully harden resin, the irradiation opening had to be made to approach to very near the affected part, and it was surely accompanied by the dirt of the irradiation opening, or the crash.
[0007] Moreover, since it was accompanied by strong generation of heat, photogenesis of a halogen lamp needed cooling by the cooling fan. Moreover, as an optical-system means for condensing light, when a concave mirror was used, it needed to maintain frequently by this concave mirror tending to become cloudy.
[0008] 2) Moreover, since the light source and a concave mirror deteriorated, always, the user needed to do the monitor of the quantity of light, and needed to adjust irradiation time.
[0009] 3) as mentioned above, in order to obtain strong luminous intensity, power needs to large-sized-ize or it is necessary to prepare a cooling system -- etc. -- there was a fault which equipment forms into a large-sized weight
[0010]
[Problem(s) to be Solved by the Invention] It was originated in order that this invention might solve the above-mentioned trouble, and the influence by heat is eliminated, and the purpose is safe and is offering the light equipment for photopolymerization type resin hardening without a light source degradation which was compact and was excellent in operability while it raises the polymerization luminous efficacy of photopolymerized type resin.
[0011]
[Means for Solving the Problem] this invention is characterized by establishing the light emitting diode in the domain whose peak emission wavelength is 430-480nm, an optical-system means to condense the light of the concerned light emitting diode, and an optical irradiation means to output the light condensed with the concerned optical-system means.
[0012]
[Function] The light outputted from light emitting diode is condensed by the optical irradiation head by the optical-system means. This light passes through an optical irradiation head, and an outgoing radiation is carried out from the irradiation opening which is the other end of the concerned optical irradiation head. And when the photopolymerized type resin which the concerned output light applied to the affected part irradiates, photopolymerized type resin carries out a polymerization.
[0013]
[Example]
(The 1st example) The optical irradiation head and 5a which are constituted by view 1 being the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 1st example of this invention, Light Emitting Diode chip with which power and 2 constitute resistance and Light Emitting Diode (light emitting diode) and 3a constitute [1] Light Emitting Diode in 3, and 4 bundling an optical fiber, and 5 bundling the end of an optical fiber are the irradiation opening.
[0014] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 1 is explained. Each Light Emitting

Diode3 to which bias voltage was impressed through resistance 2 from power 1 emits light from Light Emitting Diode chip 3a. In the domain whose peak emission wavelength is 430-480nm, especially this example, Light Emitting Diode3 is a 455nm thing, and used 20 things whose optical outputs are 1200microW. After carrying out incidence of this outgoing-radiation light to a direct file or the end of an optical fiber 4 which approached at Light Emitting Diode chip 3a, it passes along the inside of this optical fiber 4, and progresses to the other end of an optical fiber 4. The other end of two or more optical fibers 4 is bundled, it is condensed by the optical irradiation head 5 hardened by the resin, and the light which has advanced the inside of an optical fiber 4 is taken out from irradiation opening 5a of the optical irradiation head 5 as outgoing-radiation light. Thus, when the taken-out outgoing-radiation light is irradiated by the photopolymerized type resin which carried out application restoration at the affected part, this resin hardens.

[0015] Next, hardening of the photopolymerization resin in this example is described. the spectrum of light with which drawing 4 is irradiated from the light equipment of this invention -- a spectrum and the absorption wavelength band of a camphor quinone are shown it is shown in drawing 4 -- as -- the spectrum of the output light of the light equipment for photopolymerized type resin hardening of this example -- the great portion of spectrum E is contained in the wavelength domain effective in absorption of a camphor quinone of 430-480nm

[0016] Therefore, if such output light is irradiated at photopolymerized type resin, the polymerization of the photopolymerized type resin can fully be carried out by 1/about some dozens optical output of the conventional light source.

[0017] especially -- this example -- the optical plane of incidence of the fiber for condensing -- the light emitting device of Light Emitting Diode chip -- contact -- or it approaches extremely, and since it can arrange, condensing luminous efficacy becomes good and power can also be made high

[0018] (The 2nd example) View 2 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 2nd example of this invention, for 5', an optical irradiation head and 5'a of the incidence opening and 5'b are [the irradiation opening and 6] condenser lenses among drawing, and 1-3 show the same parts as drawing 1 .

[0019] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 2 is explained. Light Emitting Diode3 has arranged 20 pieces for the domain whose peak emission wavelength is 430-480nm, and the thing whose optical output it is especially 455nm and is 1200microW on the same periphery as well as drawing 1 . these -- an outgoing radiation -- light -- a condenser lens -- six -- condensing -- having -- a condenser lens -- six -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- projecting -- having . optical irradiation head 5' of this example -- abbreviation -- although two or more optical fibers of the same length were bundled and being considered as the briquette by the resin, it is a metal or the hollow pipe of a resin, and you may constitute from the thing and the glass rod itself which carried out aluminum coating so that Light Emitting Diode light might carry out total reflection of the wall

[0020] And the light condensed by optical irradiation head 5' is taken out from the irradiation opening 5'b as outgoing-radiation light through this optical irradiation head 5'. Thus, when the photopolymerized type resin which carried out application restoration irradiates at the affected part, this resin hardens the taken-out outgoing-radiation light.

[0021] In addition, about hardening of the photopolymerized type resin in this example, since it is the same as that of the 1st example, the explanation is omitted.

[0022] (The 3rd example) View 3 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 3rd example of this invention, and it is the example using the concave mirror 7 as an output light condensing system of each Light Emitting Diode.

[0023] Also in this example, Light Emitting Diode used the same thing as the 1st and the 2nd example. each -- Light Emitting Diode -- **** -- an outgoing radiation -- light -- a concave mirror -- seven -- reflecting -- having -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- condensing -- having -- although -- each -- Light Emitting Diode -- three -- an outgoing radiation -- light -- a concave mirror -- seven -- a concave mirror -- seven -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening moreover, optical irradiation head 5' -- the 2nd example -- the same -- abbreviation -- although two or more optical fibers of the same length were made into the briquette by the resin -- the above -- the same -- a metal or the hollow pipe made from a resin -- or you may constitute from a glass rod etc.

[0024] In addition, about hardening of the photopolymerized type resin in this example, it is the same as that of the 1st example, and an explanation is omitted.

[0025] Especially, at this example, since most outgoing-radiation light wave length uses Light Emitting Diode which is 430-480nm of the absorption wavelength band of a camphor quinone, resin can be stiffened by the minimum luminous intensity. Although generation of heat by the outgoing-radiation light to which it will also pull up the luminous intensity of an unnecessary wavelength band to hardening of resin, and contains such an unnecessary light in it simultaneously although the intensity as the whole light source was enlarged and the luminous intensity of the absorption wavelength band of a camphor quinone was pulled up by it in order to stiffen resin with the halogen light source conventionally caused the cloudy weather of a concave mirror, this trouble is cancelable with this invention.

[0026] By the way, the following examples are also included as an embodiment of this invention.

[0027] (1) In each Light Emitting Diode unit, a condenser lens may be arranged in the front face of Light Emitting Diode chip light emitting device, and the light which emits light from this Light Emitting Diode may be condensed.

[0028] (2) You may condense the light which carried out aluminum coding and which emits light from Light Emitting Diode in the hollow pipe in which a bore becomes small so that Light Emitting Diode light may carry out total reflection of the wall as the irradiation opening is approached instead of using an optical fiber, a condenser lens, etc. as an optical-system means.

[0029] (3) A lens may be put on the irradiation opening of an optical irradiation head, and you may collimate outgoing-radiation light.